(12) UK Patent Application (19) GB (11) 2 298 837 (13) A

(43) Date of A Publication 18.09.1996

(21) Application No 9602445.0

(22) Date of Filing 07.02.1996

(30) Priority Data
(31) 07059352 (32) 17.03.1995 (33) JP

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(51) INT CL[6]
B60R 25/02

(52) UK CL (Edition O)
B7J J101E2C

(56) Documents Cited
GB 2281888 A EP 0206861 A1 EP 0129522 A2
US 4991458 A US 4854141 A US 4750380 A

(58) Field of Search
UK CL (Edition O) B7J
INT CL[6] B60R 25/02
Online: WPI, EDOC, JAPIO

(54) Steering lock apparatus

(57) A steering lock apparatus comprises a metallic key lock collar 5a having resiliency, with at least one restraining hole 6 to receive a lock pin, mounted on a steering shaft 4. The inner peripheral surface of the key lock collar and the outer peripheral surface of a steering shaft are made to resiliently bear against each other at frictional engagement portions 9. The inner peripheral surface of the key lock collar or the outer peripheral surface of a steering shaft is made non-circular, so that the torque required for the relative rotation of the key lock collar and the steering shaft is great, if the steering wheel is forced when the locking pin is in place.

FIG. 1

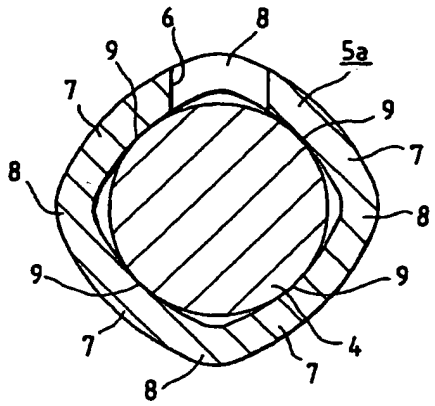

FIG. 12

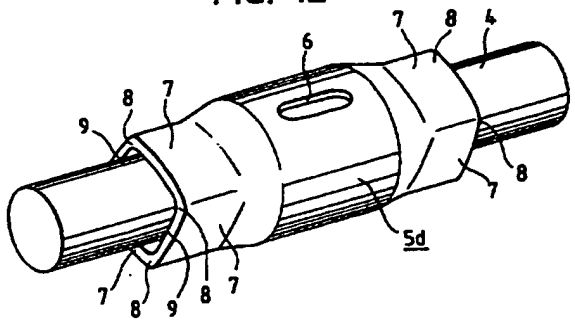

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FIG. 1

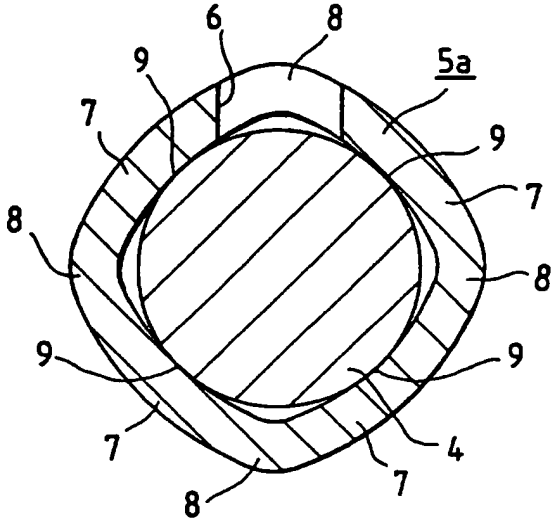


FIG. 2

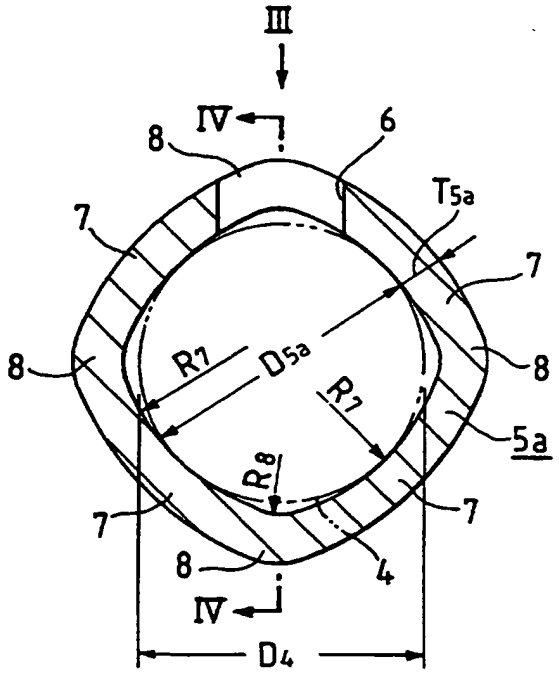


FIG. 3

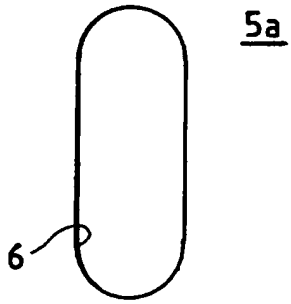


FIG. 4

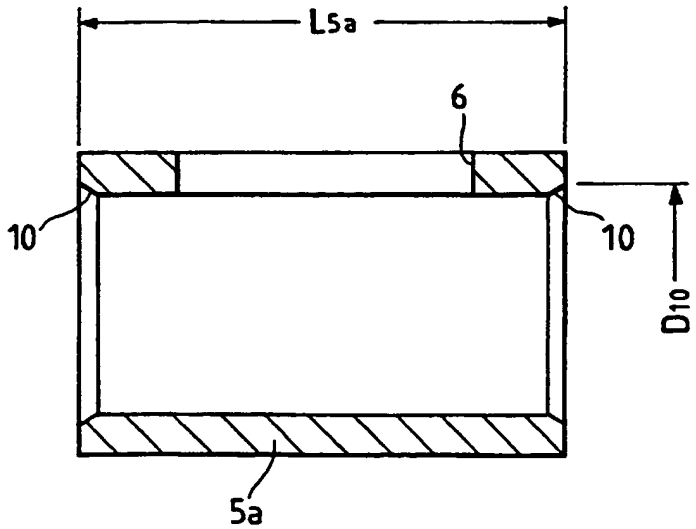
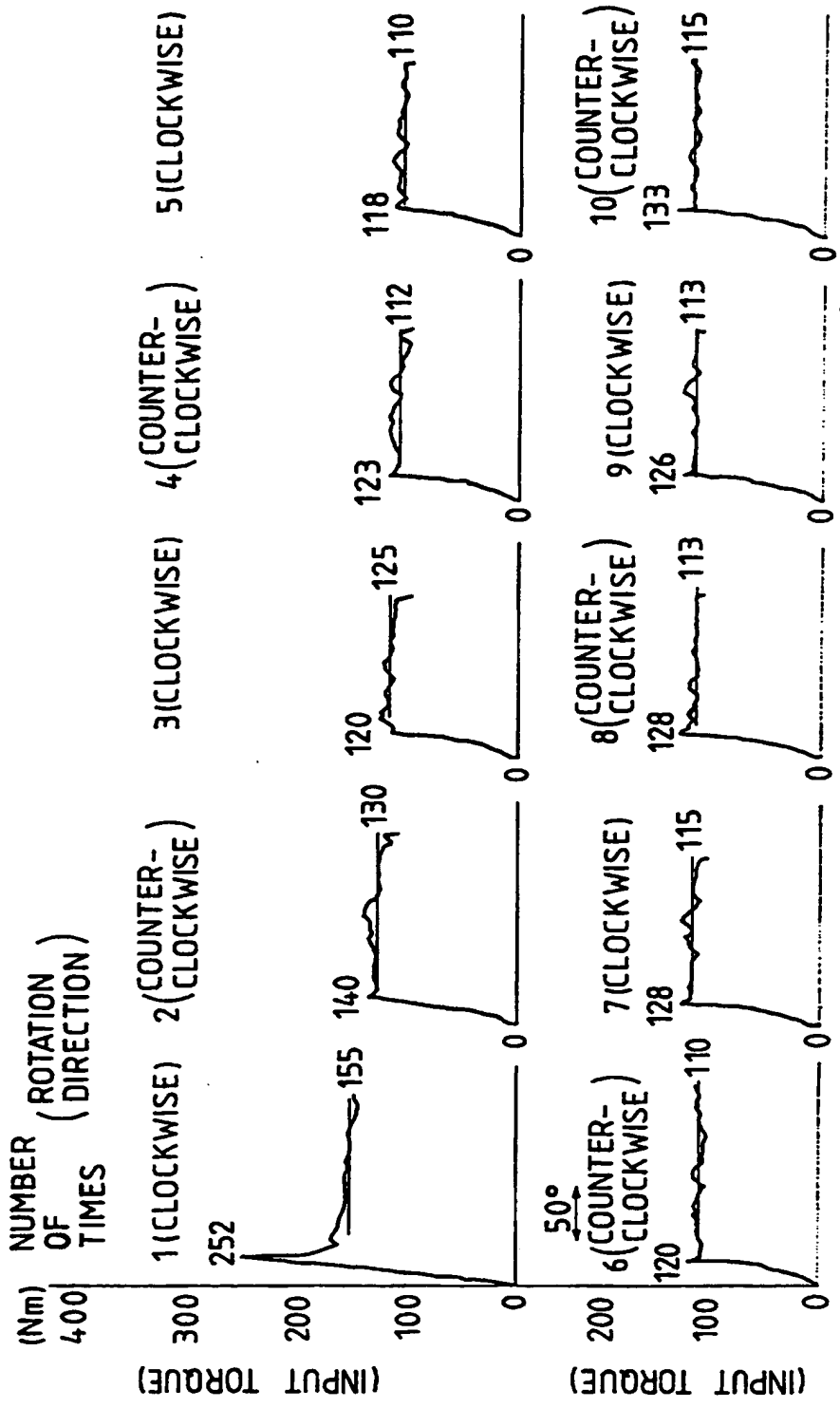


FIG. 5


(Nm)
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300
200
100
0
(INPUT TORQUE)
NUMBER OF TIMES
(ROTATION DIRECTION)
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2(COUNTER-CLOCKWISE)
3(CLOCKWISE)
4(COUNTER-CLOCKWISE)
5(CLOCKWISE)
252
155
140
130
120
125
123
112
118
110
0
50°
200
100
0
(INPUT TORQUE)
6(COUNTER-CLOCKWISE)
7(CLOCKWISE)
8(COUNTER-CLOCKWISE)
9(CLOCKWISE)
10(COUNTER-CLOCKWISE)
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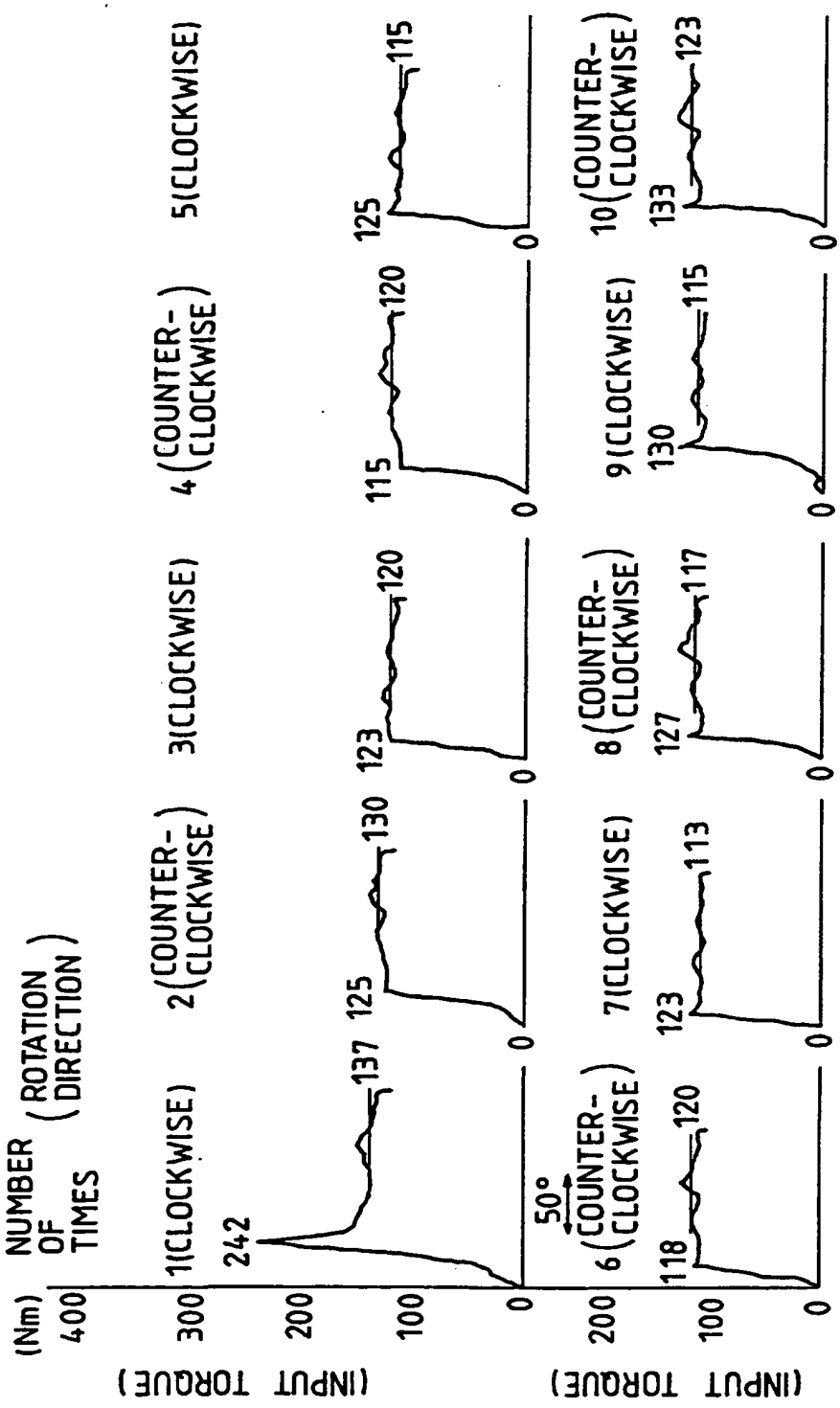
110
128
115
128
113
126
113
133
115
0

FIG. 6


NUMBER OF TIMES
(ROTATION DIRECTION)
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2(COUNTER-CLOCKWISE)
3(CLOCKWISE)
4(COUNTER-CLOCKWISE)
5(CLOCKWISE)
6(COUNTER-CLOCKWISE)
7(CLOCKWISE)
8(COUNTER-CLOCKWISE)
9(CLOCKWISE)
10(COUNTER-CLOCKWISE)
(Nm)
400
300
200
100
0
(INPUT TORQUE)
242
137
125
130
123
120
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120
123
113
127
117
130
115
133
123
0
50°

FIG. 7

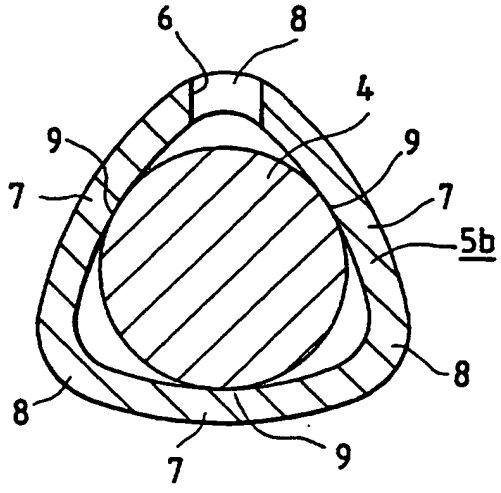


FIG. 8

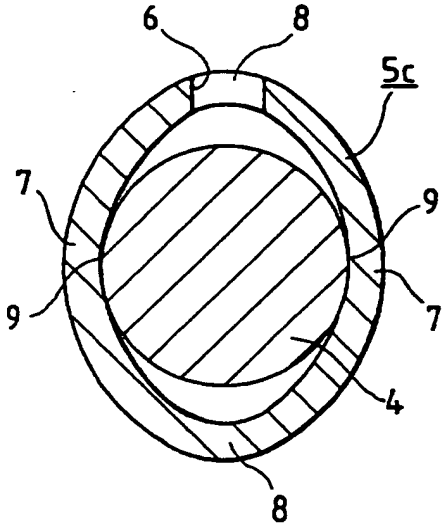


FIG. 9

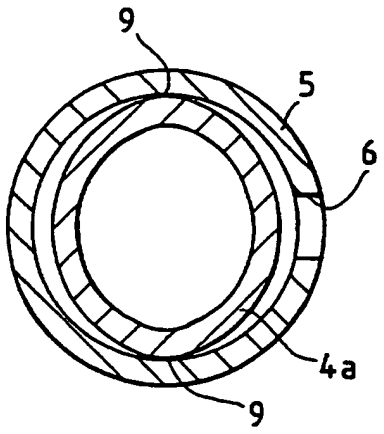


FIG. 10

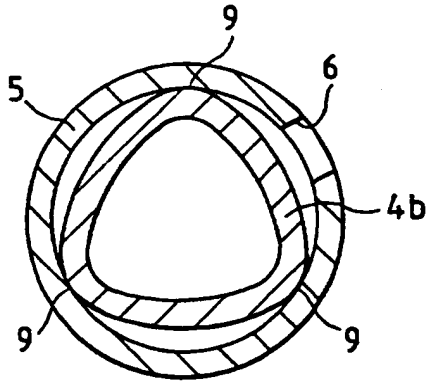


FIG. 11

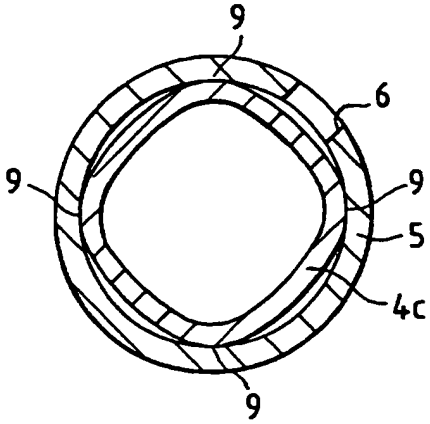


FIG. 12

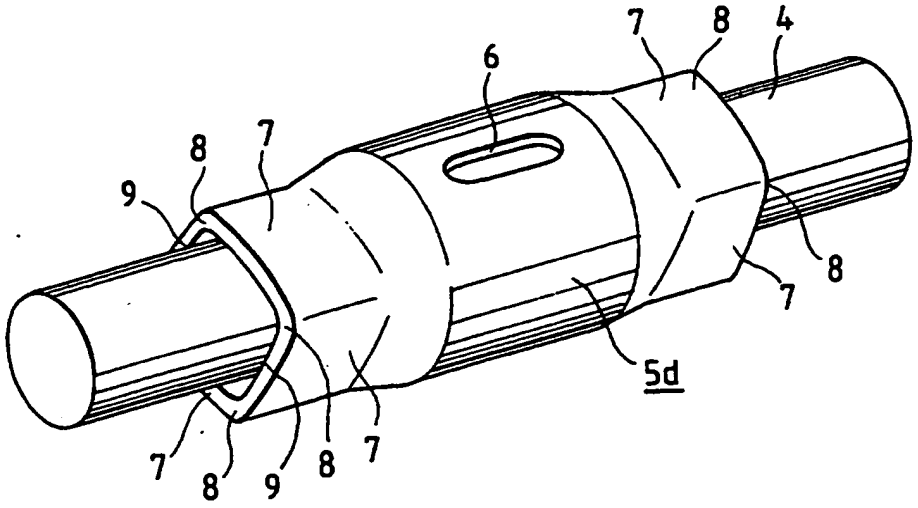


FIG. 13

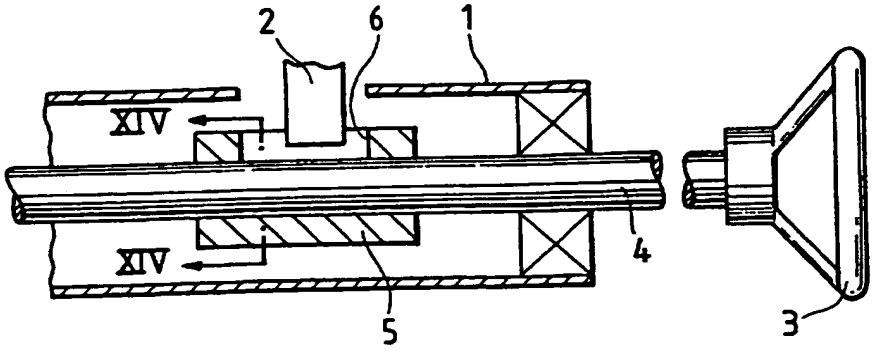
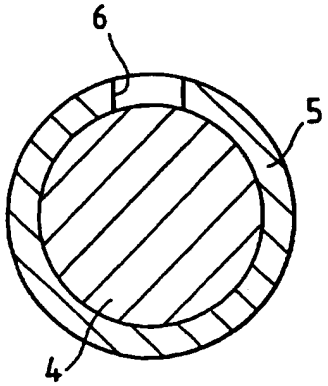


FIG. 14
PRIOR ART



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STEERING LOCK APPARATUS

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to a steering lock apparatus for locking a steering wheel with an ignition key drawn out of a keyhole for the prevention of automobile burglary to thereby prevent the steering wheel from being rotated with such a degree of force that can drive the automobile.

Related Background Art

In order to prevent automobile burglary, it is often the case with automobiles that a steering lock apparatus is provided. Figures 13 and 14 of the accompanying drawings schematically show a steering lock apparatus heretofore used for such a purpose. In the case of such a steering lock apparatus, when the locking operation of turning an ignition key, not shown, to a lock position is performed in order to draw this ignition key out of a keyhole, a lock pin 2 resiliently protrudes diametrally inwardly of the cross-section of a steering column 1 (downwardly as viewed in Figure 13) from a key cylinder, not shown, which is fixed to the steering column 1. The tip end portion of the lock pin 2 then comes into engagement with a restraining hole 6 formed in a k y lock collar 5 fixed to a steering shaft 4 rotated by a steering wheel

3. By this engagement, the steering shaft 4 is fixed to the steering column 1, whereby the rotation of the steering shaft is prevented.

The key lock collar 5 constituting the steering lock apparatus constructed and acting as described above has heretofore been fixed to the outer peripheral surface of the intermediate portion of the steering shaft 4 against rotation by pressing-in as described, for example, in Japanese Laid-Open Patent Application No. 60-50063, or by non-circular fitting as described in Japanese Utility Model Publication No. 63-32542. Accordingly, during the operation of the steering lock apparatus, unless the key lock collar 5 is rotated, the steering shaft 4 is nor rotated and steering cannot be effected. On the other hand, the outer diameters of the key lock collar 5 and the lock pin 2 cannot be made very large due to the limited installation space and further, from the viewpoint of preventing an increase in weight. Also, the rigidity of the key cylinder supporting the lock pin 2 and of the steering column 1 supporting the key cylinder cannot be made very great due to the limited installation space and from the viewpoints of preventing an increase in weight and costs. In contrast, when a man of great physical strength has operated the steering wheel 3 of a large diameter with all his strength or when he has inserted a bar into the steering wheel and rotated the latter, a

torque applied to the steering shaft 4 becomes considerably great. When such a great torque is applied to the steering shaft, there is the possibility that one or both of the lock pin 2 and the key cylinder are destroyed and the function of the steering lock apparatus is lost and the function as a burglarproof apparatus is spoiled.

Therefore, there has heretofore been proposed a structure in which the key lock collar 5 is fitted on the periphery of the intermediate portion of the steering shaft 4 for rotation only when a great torque is applied, and this structure is carried out in some parts of the world. Further, in Europe, there is a movement to oblige car-manufacturers to install such a structure. In the case of such a structure, when a great torque is applied from the steering wheel 3 to the steering shaft 4, the key lock collar 5 is rotated and therefore, the lock pin 2 and the key cylinder are not destroyed. A frictional force acting between the inner peripheral surface of the key lock collar 5 and the outer peripheral surface of the steering shaft 4 is deficient to destroy the lock pin 2 and the key cylinder, but has such a degree of magnitude that the steering operation necessary to drive an automobile cannot be performed. Accordingly, the function of the steering lock apparatus is not lost and the function as a burglarproof apparatus can be secured.

As a key lock collar constituting such an improved steering lock apparatus, there are known ones of structure described in the following publications (1) to (7):

(1) Japanese Laid-Open Patent Application No. 61-64560

In the structure described in this publication, a click mechanism is provided between the inner peripheral surface of a key lock collar and the outer peripheral surface of a steering shaft. By an increase in rotation resistance based on this click mechanism, it is made difficult for the steering shaft and the key lock collar to rotate relative to each other.

(2) Japanese Patent Publication No. 4-51379

In the structure described in this publication, an uneven engagement portion including a slit and a projection engaged with this slit is provided between the inner peripheral surface of a key lock collar and the outer peripheral surface of a steering shaft. By an increase in rotation resistance based on this uneven engagement portion, it is made difficult for the steering shaft and the key lock color to rotate relative to each other.

(3) Japanese Laid-Open Patent Application No. 58-211945

In the structure described in this publication, a key lock collar is fitted on a steering shaft by interference fit and fixed to the latter by a pin.

Even after the pin is broken, by great rotation resistance based on a great frictional force resulting from the interference fit, it is made difficult for the steering shaft and the key lock collar to rotate relative to each other.

(4) Japanese Patent Publication No. 63-36988

In the structure described in this publication, a key lock collar is fixed to the outer peripheral surface of the intermediate portion of a steering shaft by a small screw and a steel ball is held inside a recess formed in the outer peripheral surface of the steering shaft. When an excessively great torque is applied in the operative state of the steering lock apparatus and the small screw is broken, whereby the relative rotation of the steering shaft and the key lock collar is started, the steel ball eats into the inner peripheral surface of the key lock collar. By an increase in rotation resistance corresponding to the energy of the plastic deformation of the inner peripheral surface of the key lock collar resulting from the eating-in of the small ball, it is made difficult for the steering shaft and the key lock collar to rotate relative to each other.

(5) Japanese Patent Publication No. 62-60303

In the structure described in this publication, teeth formed by projections and recesses are provided at an axial end of a key lock collar, and a pin for

engaging with the teeth is provided at an outer periphery surface of a steering shaft, and the engagement of the pin and the teeth is secured by axially biasing the key lock collar with a spring. For relatively rotating the steering shaft and the key lock collar, it is necessary to axially displace the key lock collar against the biasing force of the spring. Thus, a resistance to the rotation is increased based thereupon, so that it is difficult to relatively rotate the steering shaft and the key lock collar to each other.

(6) Japanese Patent Publication No. 62-60302

In the structure described in this publication, a slit extending over the full axial length is formed at a location in the circumferential direction of a key lock collar made of an elastic material, and the inner peripheral surface of this key lock collar and the outer peripheral surface of a steering shaft are non-circularly fitted to each other. Also, during the operation of the steering lock apparatus, a lock pin is adapted to come into the slit. Usually, the key lock collar does not rotate relative to the steering shaft on the basis of the above-mentioned non-circular fitting, but is elastically deformed in a direction to widen the width dimension of the slit when an excessively great torque is applied to the steering shaft, and make the inner diameter thereof large,

whereby it is rotated. However, the torque required for this rotation is great and therefore, the driving of the vehicle is practically impossible.

(7) Japanese Patent Publication No. 6-104454

In the construction described in this publication, fitting done beyond the limit of the elasticity of a material i.e., so-called interference fit, is effected between a sleeve of a circular cross-sectional shape and a steering column.

The prior-art structures described in items (1) to (7) above are excellent in burglarproof effect as compared with the key lock collar 5 fixed to the steering shaft 4 against rotation as in the prior art, but have the following demerits in terms of cost.

First, in the structure of item (1), it is necessary that in order to construct the click mechanism, a key on the outer peripheral surface side of the steering shaft and a spring for urging this key diametrally outwardly be provided and a key engagement groove for engaging the key be formed in the inner peripheral surface side of the key lock collar. Therefore, the number of parts and the number of working steps are increased to thereby increase the cost of manufacture.

Next, in the structure of item (2), the number of parts itself is not so great, but yet th shapes of the constituents are complicated and the cost of the

working of the parts is increased. Further, to stabilize the torque when the key lock collar and the steering shaft starts their relative rotation, it is necessary to stabilize the shape accuracy and dimensional accuracy of the constituents at a high level, and this causes the cost to be higher.

Next, in the structure of item (3), the inner peripheral surface of the key lock collar which is a cylindrical surface is fitted on the outer peripheral surface of the steering shaft which is a cylindrical surface by interference fit and therefore, to stabilize the torque when the key lock collar and the steering shaft start their relative rotation, the dimensional accuracy of these peripheral surfaces must be stabilized at a high level. In other words, simply if one of the inner diameter dimension of the key lock color and the outer diameter dimension of the steering shaft deviates slightly, the aforementioned torque will deviate greatly from its design value and expected performance will become unable to be displayed. Therefore, it is necessary to enhance the accuracy of the above-mentioned dimensions, and this becomes a cause of increased costs of manufacture.

Next, in the structure of item (4), the number of parts and the number of working steps are great, and not only this becomes a cause of increased costs of manufacture, but it is thinkable that it cannot always

display a sufficient burglarproof effect to those who are familiar with the structure. That is, in the case of the structure of item (4), the steel ball plastically deforms the inner peripheral surface of the key lock collar (forms a concave groove extending in the circumferential direction), whereby the force required to rotate the steering wheel is made great. Accordingly, the force required for the first one full rotation becomes great, but the force required to rotate the steering wheel in the same portion next becomes extremely small as compared with the force in the case of the first one full rotation. By repetitively reciprocally rotating the steering wheel, the force required to rotate the steering wheel becomes small to such a degree that the driving of the automobile is possible.

Next, in the structure of item (5), as in the above-described structure of item (1), the number of parts and the number of working steps are great, and this leads to increased costs of manufacture.

Further, the structure of item (6) is small in the number of parts, but it is considered that it is difficult for this structure to make the side of cost and the side of burglarproof performance compatible. That is, as the elastic material forming the key lock collar, it would occur to employ spring steel, synthetic resin, hard rubber or the like. First, in

the case of spring steel, sufficient strength can be secured and there is no problem in burglarproof performance, but the labor of working the key lock collar having desired dimension and shape becomes cumbersome, and this means a disadvantage in terms of costs. In contrast, synthetic resin and hard rubber make the working easy, but instead, they cannot obtain sufficient strength and are considered to be insufficient in terms of burglarproof performance.

In the publication of item (7), there is not disclosed an engagement portion of a non-circular cross-sectional shape.

SUMMARY OF THE INVENTION

The present invention provides a steering lock apparatus which is easy and inexpensive to manufacture and moreover displays a sufficient burglarproof performance without requiring excess parts.

The steering lock apparatus of the present invention, like the aforedescribed prior-art steering lock apparatuses, is provided with a steering shaft having a steering wheel mounted on the rear end portion thereof, a steering column rotatably supporting the steering shaft therein, a key lock collar mounted on the outer peripheral surface of the intermediate portion of the steering shaft, a restraining hole formed in the key lock collar, a key cylinder mounted

on the steering column, and a lock pin protruding from the key cylinder diametrally inwardly of the cross-section of the steering column on the basis of the locking operation and having its tip end portion engaged with the restraining hole.

Particularly, the steering lock apparatus of the present invention satisfies the following requirements (1) to (3):

(1) The outer peripheral surface of the intermediate portion of the steering shaft and a portion of the inner peripheral surface of the key lock collar together constitute frictional engagement portions resiliently bearing against each other;

(2) One of the outer peripheral surface and the inner peripheral surface together constituting the above-described frictional engagement portions is formed into a non-circular shape and the other of said outer peripheral surface and said inner peripheral surface is formed into a circular shape; and

(3) The diameter of the maximum inscribed circle of said inner peripheral surface when both of the key lock collar and the steering shaft are in their free states is smaller than the diameter of the minimum circumscribed circle of said outer peripheral surface.

In the case of the steering lock apparatus of the present invention constructed as described above, a torque required for the relative rotation of the

steering shaft and the key lock collar becomes sufficiently great by the frictional engagement portions constituted by at least axial portions of the outer peripheral surface of the intermediate portion of the steering shaft and the inner peripheral surface of the key lock collar resiliently bearing against each other. The frictional force of the frictional engagement portions is provided on the basis of the fact that one or both of the steering shaft and the key lock collar are resiliently deformed and therefore, more or less difference in dimensional accuracy does not greatly affect the magnitude of the frictional force. Accordingly, the manufacturing cost of each constituent member does not increase in order to stabilize the frictional force and stabilize the torque required for the relative rotation of the steering shaft and the key lock collar. Also, even when a great torque is applied to the steering shaft, whereby the steering shaft and the key lock collar are rotated relative to each other, plastic deformation or the like occurs to neither of said two peripheral surfaces. Accordingly, even when the steering wheel is repetitively rotated, the force required to rotate the steering wheel is not extremely reduced and a sufficient burglarproof performance can be maintained.

Also, the torque required for the relative rotation of the steering shaft and the key lock collar

can be delicately adjust d by suitably changing the axial length of the frictional engagement portions, the shape of the peripheral surface formed into a non-circular shape, the difference between the diameter of the maximum inscribed circle of the inner peripheral surface of the key lock collar in its free state and the diameter of the minimum circumscribed circle of the outer peripheral surface of the steering shaft, the resiliency of the key lock collar or the steering shaft, etc. Accordingly, said torque can be adjusted arbitrarily and reliably in accordance with the size of an automobile in which the steering lock apparatus is to be mounted, the diameter of the steering wheel, etc.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a view showing a first embodiment of the present invention and corresponding to a cross-section along the line XIV - XIV of Figure 13.

Figure 2 is a cross-sectional view of a key lock collar used in a performance test which is taken at the same position as Figure 1.

Figure 3 is a view showing the shape of a restraining hole and taken along the arrow III of Figure 2.

Figure 4 is a cross-sectional view taken along the line IV - IV of Figure 2.

Figure 5 is a graph showing a first example of the

result of the performance test.

Figure 6 is a graph showing a second example of the result of the performance test.

Figure 7 is a view showing a second embodiment of the present invention and corresponding to the cross-sectional along the line XIV - XIV of Figure 13.

Figure 8 is a view showing a third embodiment of the present invention and corresponding to the cross-section along the line XIV - XIV of Figure 13.

Figure 9 is a view showing a fourth embodiment of the present invention and corresponding to the cross-section along the line XIV - XIV of Figure 13.

Figure 10 is a view showing a fifth embodiment of the present invention and corresponding to the cross-section along the line XIV - XIV of Figure 13.

Figure 11 is a view showing a sixth embodiment of the present invention and corresponding to the cross-section along the line XIV - XIV of Figure 13.

Figure 12 is a perspective view of the essential portions of a seventh embodiment of the present invention.

Figure 13 is a substantially longitudinal cross-sectional side view showing a steering lock apparatus to which the present invention is directed.

Figure 14 is a cross-sectional view taken along the line XIV - XIV of Figure 13 and showing the structure according to the prior art.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 shows a first embodiment of the present invention. The feature of the steering lock apparatus of the present invention resides in the structure of a portion in which a key lock collar 5a is mounted on a steering shaft 4. In the other points, the construction and action of the present invention are similar to those of the aforedescribed prior-art structure and therefore, overlapping showings and descriptions will be omitted herein and chiefly the characteristic portions of the present invention will be described hereinafter. In the case of the present embodiment, the key lock collar 5a is formed into a square cylindrical shape by a resilient metallic plate such as a carbon steel plate. That is, the circumferential end edges of four side portions 7, 7 each having a large radius of curvature and having their outer peripheral sides formed into arcuate convex surfaces are continued to one another by four corner portions 8, 8 each having a small radius of curvature and having their outer peripheral sides formed into arcuate convex surfaces. A restraining hole 6 which is an axially long slot is formed in the intermediate portion of any one corner portion 8 in the axial direction thereof (the front to back direction as viewed in Figure 1).

The diameter of the maximum inscribed circle of

the inner peripheral surface of the key lock collar 5a having its inner peripheral surface made into a non-circular, rectangular cylindrical surface by thus forming the whole into a rectangular cylindrical shape is made smaller than the outer diameter of the steering shaft 4 in the free state of the key lock collar 5a. The outer peripheral surface of the intermediate portion of the steering shaft 4 and the circumferentially intermediate portions of the side portions 7, 7 constituting the inner peripheral surface of the key lock collar 5a together constitute frictional engagement portions 9, 9 resiliently bearing against one another.

In the case of the steering lock apparatus of the present invention comprising the key lock collar 5a and the steering shaft 4 combined together as described above, the torque required for the relative rotation of the steering shaft 4 and the key lock collar 5a becomes sufficiently great by the frictional engagement portions 9, 9. The frictional force in the frictional engagement portions 9, 9 is provided on the basis of the fact that the side portions 7, 7 constituting the key lock collar 5a are resiliently deformed diametrally outwardly. Accordingly, if the diameter of the maximum inscribed circle of the inner peripheral surface of the key lock collar 5a in its free state is only made smaller than the outer diameter of the steering shaft

4, more or less difference in dimensional accuracy will not greatly affect the magnitude of the frictional force. Accordingly, the manufacturing costs of the steering shaft 4 and key lock collar 5a which are the constituent members of the steering lock apparatus do not increase in order to stabilize the above-described frictional force and stabilize the torque required for the relative rotation of the steering shaft 4 and the key lock collar 5a.

Also, for example, even when one who tries to steal an automobile operates a steering wheel with a strong force and a great torque is applied to the steering shaft 4, whereby the steering shaft 4 and the key lock collar 5a are rotated relative to each other, plastic deformation or the like occurs to neither of the outer peripheral surface of the steering shaft 4 and the inner peripheral surface of the key lock collar 5a which constitute the frictional engagement portions 9, 9. Accordingly, even when the steering wheel is repetitively rotated, the force required to rotate the steering wheel is not extremely reduced and a sufficient burglarproof performance can be maintained.

An experiment carried out regarding this point by the inventor will now be described with reference to Figures 2 to 6. The key lock collar 5a as shown in Figures 2 to 4 was used in the experiment. The length L_{5a} of this key lock collar 5a was 50 mm, the plate

thickness T_{5a} thereof was 3.5 mm, the radius of curvature R_7 of the inner peripheral surface of each side portion 7, 7 was 16 mm, the radius of curvature R_8 of the inner peripheral surface of each corner portion 8, 8 was 1 to 3 mm, and the diameter D_{5a} of the maximum inscribed circle of the key lock collar 5a in its free state was 18.4 to 18.7 mm. Also, chamfers 10, 10 each having an angle of inclination of 30° were formed on the inner peripheral edges of the opposite end opening portions of the key lock collar 5a. The diameter D_{10} of each chamfer 10, 10 was 19.5 mm. Two key lock collars 5a having such a shape and dimensions were made by STKM (JIS G 3445) which was a carbon steel tube for mechanical structure and the hardness thereof was set to HRC 25 - 33, and the respective key lock collars 5a were fitted onto a steering shaft 4 having an outer diameter of 19.0 mm.

With the key lock collars 5a kept fixed, a force in the direction of rotation was imparted to the steering shaft 4, and the torque required to rotate this steering shaft 4 was measured. This measuring work was done over five cycles in total with the following process as one cycle.

[The steering shaft 4 is brought to its neutral position (the angle of rotation is 0°)] → [it is rotated by 180° clockwisely] → [the steering shaft 4 is returned to its neutral position] → [it is rotated by

180° counter-clockwisely] → [the steering shaft 4 is returned to its neutral position].

Such a cycle was repeated five times for each sample, and the torques required when the sample was rotated clockwisely (R) and when the sample was rotated counter-clockwisely (L) were measured (five times each for the clockwise rotation and the counter-clockwise rotation, ten times in total), and the results thereof are shown in Figures 5 and 6. As is apparent from Figures 5 and 6 showing the results of such a test, in the case of the steering lock apparatus incorporating therein the key lock collar 5a having the shape as shown in Figures 1 to 4, even when the steering wheel is repetitively rotated, the force required to rotate the steering wheel is not extremely reduced. Particularly, a sufficiently great value of 10 kgf•m (100 N•m) or greater can be secured as the rotational torque (10 (L)) in the last one of the five cycles repeated. The diameter of a popular steering wheel is of the order of 40 cm (20 cm for the radius) at largest and therefore, if the torque required to rotate the steering shaft 4 is 10 kgf•m or greater, to rotate the steering wheel during the operation of the above-described steering lock apparatus, it is necessary to apply a force exceeding 50 kgf•m to the steering wheel even after five cycles has passed. It is impossible to an ordinary person to apply such a great force while

driving an automobile and therefore, it will be seen that the steering lock apparatus of the present invention can maintain a sufficient burglarproof performance.

In the first embodiment illustrated, a restraining hole 6 for bringing the tip end portion of a lock pin 2 (Figure 13) into engagement with the key lock collar 5a is formed only in one corner portion 8 in the circumferential direction thereof. However, two or more such restraining holes 6 may be formed, for example, in the corner portions 8, 8 present at two locations in the diagonal direction. Also, the restraining hole need not always be formed in the corner portion 8, but the restraining hole 6 may be formed in the circumferentially intermediate portions of one or more of the four side portions 7, 7. Further, the steering shaft 4 need not be a solid member as in the illustrated embodiment, but may also be a hollow tubular one.

Figure 7 shows a second embodiment of the present invention. In this embodiment, a key lock collar 5b is formed into the shape of a triangular cylinder. That is, the circumferential end edges of three side portions 7, 7 each having a large radius of curvature and having the outer peripheral sides formed into arcuate convex surfaces are continued to one another by three corner portions 8, 8 each having a small radius

of curvature and having their outer peripheral sides formed into arcuate convex surfaces. A restraining hole 6 which is an axially long slot is formed in the intermediate portion of any one corner portion 8 in the axial direction thereof (the front to back direction as viewed in Figure 7). This embodiment is similar to the above-described embodiment in the other constructions and action and in that the number and location of the restraining hole 6 are not limited to the illustrated ones and that the steering shaft 4 may be hollow tubular.

Figure 8 shows a third embodiment of the present invention. In this embodiment, a key lock collar 5c is formed into the shape of a cylinder having a Rugby ball-like cross-sectional shape. That is, the circumferential end edges of two side portions 7, 7 each having a large radius of curvature and having their outer peripheral sides formed into arcuate convex surfaces are continued to each other by two corner portions 8, 8 each having a small radius of curvature and having their outer peripheral sides formed into arcuate convex surfaces. A restraining hole 6 which is an axially long slot is formed in the intermediate portion of one corner portion 8 in the axial direction thereof (the front to back direction as viewed in Figure 8). This embodiment is similar to the above-described first and second embodiments in the other

constructions and action and in that the number and location of the restraining hole 6 are not limited to the illustrated ones and that the steering shaft 4 may be hollow tubular.

Figure 9 shows a fourth embodiment of the present invention. In this embodiment, a steering shaft 4a is formed into the shape of a tube having a Rugby ball-like cross-sectional shape. Also, a key lock collar 5 is formed into a mere cylindrical shape as in the aforedescribed prior-art structure. In the free state of the steering shaft 4a, the diameter of the minimum circumscribed circle of this steering shaft 4a is slightly larger than the inner diameter of the key lock collar 5. During the combination of the steering shaft 4a and the key lock collar 5, the key lock collar 5 is fitted onto the steering shaft 4a while the cross-sectional shape of the steering shaft 4a is flattened in the direction of the major axis thereof. In a state in which the fitting work has been completed, the portions of contact between the outer peripheral surfaces of the opposite end portions of the steering shaft 4a in the direction of the major axis thereof and the inner peripheral surface of the key lock collar 5 constitute frictional engagement portions 9, 9. This embodiment is similar to the aforedescribed embodiments in the other constructions and action and in that the number and location of the restraining hole 6 are not

limited to the illustrated ones.

Figure 10 shows a fifth embodiment of the present invention. In this embodiment, a steering shaft 4b is formed into a substantially triangular tubular shape. Also, a key lock collar 5 is formed into a mere cylindrical shape as in the aforedescribed prior-art structure. In the free state of the steering shaft 4b, the diameter of the minimum circumscribed circle of this steering shaft 4b is a little larger than the inner diameter of the key lock collar 5. During the combination of the steering shaft 4b and the key lock collar 5, the key lock collar 5 is fitted onto the steering shaft 4b while the cross-sectional shape of this steering shaft 4b is resiliently deformed in a direction to approximate to a circular shape. In a state in which the fitting work has been completed, the portions of contact between the outer peripheral surfaces of the corner portions of the steering shaft 4b and the inner peripheral surface of the key lock collar 5 constitute frictional engagement portions 9, 9. This embodiment is similar to the above-described embodiments in the other constructions and action and in that the number and location of the restraining hole 6 are not limited to the illustrated ones.

Figure 11 shows a sixth embodiment of the present invention. In this embodiment, a steering shaft 4c is formed into a substantially square tubular shape.

Also, a key lock collar 5 is form d into a mere cylindrical shape as in the aforedescribed prior-art structure. In the free state of the steering shaft 4c, the diameter of the minimum circumscribed circle of this steering shaft 4c is a little larger than the inner diameter of the key lock collar 5. During the combination of the steering shaft 4c and the key lock collar 5, the key lock collar 5 is fitted onto the steering shaft 4c while the cross-sectional shape of this steering shaft 4c is resiliently deformed in a direction to approximate to a circular shape, as in the above-described fifth embodiment. In a state in which the fitting work has been completed, the portions of contact between the outer peripheral surfaces of the corner portions of the steering shaft 4c and the inner peripheral surface of the key lock collar 5 constitute frictional engagement portions 9, 9. This embodiment is similar to the above-described embodiments in the other constructions and action and in that the number and location of the restraining hole 6 are not limited to the illustrated ones.

Figure 12 shows a seventh embodiment of the present invention. In this embodiment, only the axially opposite end portions of a key lock collar 5d are formed into a rectangular cylindrical shape and the axially intermediate portion thereof in which a restraining hole 6 is formed is formed into a mere

cylindrical shape. The inner peripheral surfaces of the above-mentioned axially opposite end portions are made to resiliently bear against the outer peripheral surface of the intermediate portion of a steering shaft 4 to thereby constitute frictional engagement portions 9, 9. This embodiment is similar to the aforedescribed first embodiment in the other constructions and action.

In the above-described embodiments, the torque required for the relative rotation of the steering shaft 4 and the key lock collars 5a, 5b, 5c, 5d can be arbitrarily adjusted by changing the shapes, etc. of the key lock collars 5a, 5b, 5c, 5d. For example, the above-mentioned torque can be delicately adjusted by suitably changing the axial length of the frictional engagement portions 9, 9, the shape of the inner peripheral surface or the outer peripheral surface formed into a non-circular shape, the difference between the diameter of the maximum inscribed circle of the inner peripheral surface of the key lock collars 5a, 5b, 5c, 5d in its free state and the diameter of the minimum circumscribed circle of the outer peripheral surface of the steering shaft 4, and further the resiliency or the like of the key lock collars 5a, 5b, 5c, 5d or the steering shafts 4a, 4b, 4c. Accordingly, the above-mentioned torque can be adjusted arbitrarily and reliably in accordance with the size of an automobile in which the steering lock apparatus is

to be mounted and the diameter or the like of the steering wheel.

The steering lock apparatus of the present invention is constructed and acts as described above and therefore can obtain the following excellent effects:

(a) The number of parts is small and therefore, not only the working of parts, the custody of parts and the assembling work are simple and a reduction in cost can be achieved, but also the reliability of the steering lock apparatus constructed by combining a plurality of parts together can be improved;

(b) The key lock collar can be easily made, for example, by subjecting a metallic tube to simple plastic working such as press working or drawing, and this leads to a small number of parts as well as a reduced cost;

(c) The adjustment of the torque at which the key lock collar and the steering shaft begin to rotate relative to each other is easy and moreover, the adjusted torque is stable and therefore, the performance of the steering lock apparatus is stable and a reliable burglarproof effect can be obtained; and

(d) Even if the steering wheel is repetitively operated, the reduction in torque is slight and therefore, a reliable burglarproof effect is obtained.

CLAIMS:

1. A steering lock apparatus provided with a steering shaft having a steering wheel mounted on the rear end portion thereof, a steering column rotatably supported said steering shaft therein, a key lock collar mounted on the outer peripheral surface of the intermediate portion of said steering shaft, a restraining hole formed in said key lock collar, a key cylinder mounted on said steering column, and a lock pin protruding from said key cylinder diametrally inwardly of the cross-section of said steering column on the basis of the locking operation and having its tip end portion engaged with said restraining hole, wherein

(1) the outer peripheral surface of the intermediate portion of said steering shaft and a portion of the inner peripheral surface of said key lock collar together constitute frictional engagement portions resiliently bearing against each other,

(2) one of the outer peripheral surface and the inner peripheral surface together constituting said frictional engagement portions is formed into a non-circular shape and the other of said outer peripheral surface and said inner peripheral surface is formed into a circular shape, and

(3) the diameter of the maximum inscribed circle of said inner peripheral surface when both of said key

lock collar and said steering shaft are in their free states is smaller than the diameter of the minimum inscribed circle of said outer peripheral surface.

2. The steering lock apparatus of Claim 1, wherein the outer peripheral surface of said steering shaft is circular, and the inner peripheral surface of said key lock collar is non-circular.

3. The steering lock apparatus of Claim 1, wherein the outer peripheral surface of said steering shaft is non-circular, and the inner peripheral surface of said key lock collar is circular.

4. The steering lock apparatus of Claim 1, wherein said non-circular shape is an ellipse, a triangle or a square.

5. In, or for, a steering lock apparatus, a lock collar provided with at least one lock pin receiving hole fitted to a steering shaft portion such that at circumferentially spaced apart locations said collar engages said shaft portion with a fit whereby said collar is rotatable relative to said shaft portion on application of a relative torque therebetween above a predetermined amount which is

greater than the amount of torque applied to said shaft portion for steering.

6. In, or for, a steering lock apparatus a lock collar having at least one lock pin receiving hole and being frictionally fitted to a steering shaft portion for rotation therewith on application of torques to said shaft portion up to a set amount, said collar resiliently engaging said shaft portion at engaging portions of an inner peripheral surface of the collar and an outer peripheral surface of the shaft portion, one of which peripheral surfaces is non-circular.

7. A steering lock apparatus substantially as hereinbefore described with reference to Figures 1 to 4, 7, 8, 9, 10, 11 or 12 of the accompanying drawings.

The Patent Office

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Application No: GB 9602445.0
Claims searched: 1 to 7

Examiner: Colin Thompson
Date of search: 4 March 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): B7J

Int Cl (Ed.6): B60R 25/02

Other: Online: WPI, EDOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X,P	GB 2281888 A	(Valeo Security Systems Ltd)	5
X	EP 0206861 A1	(Cycles Peugeot)	1,5,6
X	EP 0129522 A2	(Honkanen)	5,6
X	US 4991458 A	(Stuedemann)	1,5,6
X	US 4854141 A	(Haldric)	5,6
X	US 4750380 A	(Hoblingre)	1,5,6

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